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Spatial and temporal transformation from transhumance to agropastoralism along Maasai steppe, Tanzania

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Abstract

Understanding land use/cover changes is one of the key issues in addressing environmental sustainability. This study used time-series satellite images to classify land use/cover changes in three wards in Simanjiro district. Further, random sampling techniques were used to interview communities on the knowledge and impacts of land use changes. The findings show expansion in agricultural land and barren lands by 72.5% and 51.8%, respectively. The results further show that woodland, shrubland grassland decreased by 62.86% and 34.99%, respectively. The major drivers for the observed changes are population increased and which results from immigration, creating high pressure on land resources over the study area, resulting in loss of grazing land and water resources for livestock and domestic use. Other drivers are inadequate land use plans and land trading. The total blockage of the grazing routes due to the expansion of agricultural land may spark conflict between farmers and pastoral groups. Initiatives taken by the pastoral communities include migration to wetland areas, pasture restoration, buying hay, destocking, and keeping resistant breeds. However, the need for modern livestock keeping with small productive herds is proposed in this study. The findings of this study are useful in advancing the strategies towards maintaining a balance between environmental conservation and resource utilization.

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Introduction

East Africa harbours almost one half of the world's pastoral community (Fratkin, 2001). The rapid land use land cover (LULC) changes arguably threatens the future environmental and socioeconomic sustainability along the east African region (Kariuki *et al.*, 2021). The interaction between humans and the natural environmental processes is among the drivers of land use/cover changes at different spatial and temporal scales (McCabe, 1997; Ren *et al.*, 2019). Studies show the rapid conversion to built-up areas and agriculture at alarming levels (Said *et al.*, 2019). Furthermore, grazing land and forest are converted to farmland at alarming rates over the East African region (Olson, 2006). Thus, the need to assess these changes in spatial and temporal scales is necessary.

Conservation has been an important tool to reduce the rates of land-use changes, especially in Sub Saharan Africa. However, most of the protected areas in sub-Saharan Africa are situated in the rangelands (Kideghesho *et al.*, 2013). However, the conversion of grazing land to other forms have been reported at different rates over these areas. For example, conversion of the grazing land to cultivation around mount Kilimanjaro slopes that serves as a transboundary between Tanzania and Kenya has gained attention in previous studies (Nyariki *et al.*, 2009).

In Tanzania, conservation activities have been a powerful factor in influencing Tanzania's environments and land use for decades (Brockington, 2008). One example is the Ngorongoro conservation area (Ngorongoro crater), where human beings and animals make a life together. In addition, studies suggest that Tanzania's political economy is shaped by an environmental-conservation complex consisting of its protected area estate, tourist and hunting revenues, and donor interest (Brockington, 2008). However, Studies in Nothern Tanzania reports the increasing conversion to agricultural land and built-up areas over the next decade if no serious management measures to revert the current land-use change rates(Said *et al.*, 2021). Studies report that 13% of the land cover in Mt. Kilimanjaro on the Kenyan side changed between 1973 and 2000; almost all changes were from rangelands to farmlands (99%) (Oslon, 2004). These changes call for a management framework that requires a better understanding of the changes and the drivers.

In Semi-arid parts of Tanzania, pastoralism plays a central role in supporting the livelihood and sustainability of rural suburbs in many ways (Yanda and William, 2010). In these areas, pasture and land availability become essential livelihood items. However, an increase in population and land unavailability threatens pastures availability (Raikes, 1981). This phenomenon may be a reason for increasing conflicts between farmers and livestock keepers in various parts of the country (Benjaminsen *et al.*, 2009; Msuya, 2013). In addition, the current land use and climate changes are a threat that needs thorough assessment (Rugumamu, 1989).

Livestock keeping provides social, cultural, and economic benchmarking to many rural communities in low-income settings, particularly those in marginal, semi-arid and arid environments (de Glanville *et al.*, 2021). In these environments, livestock can also provide the security to pursue other livelihood activities, which in many cases are not reliable due to inadequate resources, including local rainfall (Jahnke and Jahnke, 1982). However, livestock mobility allows these communities to move from one area to another common land over a potentially wide geographic area (transhumance) (Ogola *et al.*, 2018). This migration between typical seasonal zones is a part of transhumant systems, whereas agropastoral systems are characterized as those that include crop cultivation in addition to livestock production (Niamir, 1990).

However, the northern part of the country reported being threatened by the ecological shifts resulting from increased land-use changes and prolonged droughts (Yanda and William, 2010). As a result, many of these rangelands are regarded as degraded and unproductive. Studies report anti-pastoral policy environment as a reason for reduced access to

pastures and water, especially during the dry season (Benjaminsen *et al.*, 2009). This situation partly explains why there is an increasing number of pastoral communities engaging in cultivation. Thus, it triggers the need to understand these changes and design the best management strategies for sustainable environmental management.

Some of the challenges facing pastoralism over the East African region include population growth, conversion of herding lands to agriculture, protected areas, urban growth, drought, and civil wars (Fratkin, 2001). In Tanzania, population increase strengthens the demand and competition for resources that increase the exploitation of resources at the highest level beyond the capacity of the available resources(Said *et al.*, 2019; Yanda and William, 2010). Although, some adaptation measures include the oscillation between pastoralism and agriculture, hunting, gathering, and employment (Spencer, 1998). However, this transformation is viewed to be rapid and unsustainable. One impact is that it may accelerate the current land-use change, resulting in adverse environmental impacts.

This paper is motivated by the assumption that transformation from transhumance with large herds of livestock to agropastoralism with small herds of livestock has converted a large portion of pastureland to agricultural land. These changes are rapid and environmentally unsustainable; thus, this triggers the need to perform a detailed analysis of land use/cover changes and the factors driving these changes. To address these issues, the objectives of this study were centred on three major issues; to analyze the land use/cover for the three villages with a high population of pastoral communities, to assess the community knowledge on these changes, and to assess the major drivers and environmental issues resulting from this transformation.

Materials and methods

The study area

This study was conducted in three wards of the Simanjiro district (Fig. 1). Simanjiro district is a semi-arid area characterized by a sparse population, divided into six administrative divisions with 17 Wards and 39 registered villages. It has a land area of 20,591km^2, of which 600km^2 is fertile land, 12,682km^2 is hunting blocks, and the rest are hilly areas (URT, 2012).

Simanjiro district is a largely semi-arid zone with a bimodal rainfall regime, the annual rainfall in Simanjiro district sums to 650mm per annum, and temperature varies between 18-30˚C (Salekwa *et al.*, 2014). The short rains are between November and December, whereas the long rains are from February to April. The dominant vegetation is wooded bushland and bush occupied by the Kisongo Maasai pastoralists.

According to the 2012 census, the population was 178,693, and the population growth rate per annum was found to be 2.37% per year (URT, 2012). Simanjiro is mostly open woodland, bushy forests and grassland vegetation (Salekwa *et al.*, 2014).

The Simanjiro district borders the Tarangire National part, making it an important area for wildlife dispersal, with humans and wildlife interaction (Salekwa *et al.*, 2014). The dominant vegetation is wooded bushland and bush occupied by the Kisongo Maasai pastoralists, making pastoralism a vital livelihood activity in the area.

Data collection methods

Household Survey techniques

The study randomly administered open-ended and closed-ended questionnaires to get the required information from the households. The questionnaire covered socioeconomic and demographic information, forms and causes of land use and impacts, and adaptation measures.

Key informant interviews were also conducted in each ward, including chairpersons, Ward Executive Officers, and ward livestock field officers. The motive behind the use of this method was to capture the knowledge and experience from the appropriate government officials and community elders.

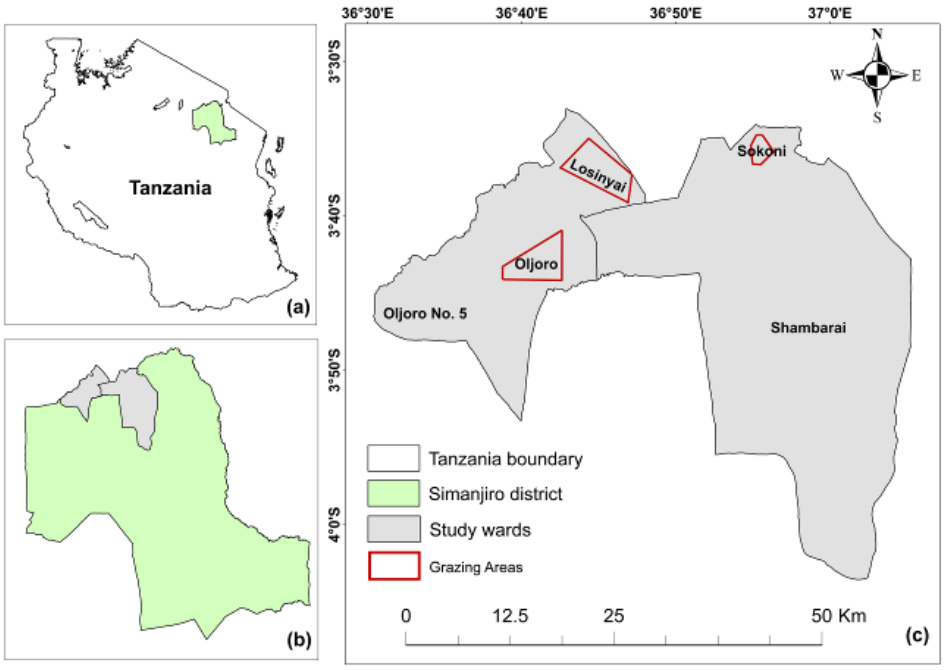

Fig. 1. The study area.

Geospatial techniques

The satellite images were freely accessed on the United States Geological Survey (USGS) website, through Global Visualization Viewer (GLOVIS) through https: glovis.usgs.gov/ accessed in July 2020. This analysis used the Operation Land Imager (OLI) for 2014 and Landsat 5 for 1987 Landsat images for land use/cover classification. The description of the imagery characteristics is shown in Table 1. The imageries were rectified to fit the geographical location of the study area by using ground control points which were collected physically in the study area. Composite of imagery was conducted by combining visible bands and near-infrared imageries.

Table 1. Remote sensed data used in the analysis of forest change.

Image	Sensor	Path/row	Source of data	Data resolution (m)
Landsat 5	TM	168/63	https: glovis.usgs.gov/	30 x 30
Landsat 8	OLI_TIRS	168/63	https: glovis.usgs.gov/	30 x 30

Imagery enhancement (Histogram equalization) and pan-sharpening algorithm were used to improve the resolution of the satellite imagery. Then, satellite imagery was extracted to the extent of the area of interest. Supervised Maximum likelihood classification algorithm (Arc GIS 10.2) was used to produce the land cover maps for Losinyai, Oljoro no 5, and Shambarai wards for 1987 and 2014. Then accuracy assessment was done to ascertain the accuracy of the classified images. Finally, post-classification change detection was adopted to determine landcover changes. Regarding land cover mapping, four land covers (Table 2) were used for classification: woodland, shrubs and grassland, bare soil, and farmland.

Table 2. Description of land cover classes.

SN	Land cover class	Description
1	Woodland	All areas with dense forest or closed canopy
2	Shrubs and Grassland	All areas with scattered trees and short grasses
3	Bare Soil	Areas covered with bare soil or rock
4	Farmland	All areas with crops

Image classification and accuracy assessment

The geometrically corrected and georeferenced images were used to perform the supervised classification by the maximum likelihood algorithm in ArcMap. The training samples and signature files were used to train the program to identify the correct spectral signatures. Furthermore, the ground surveyed points and Google Earth images were used to identify features of ambiguous features.

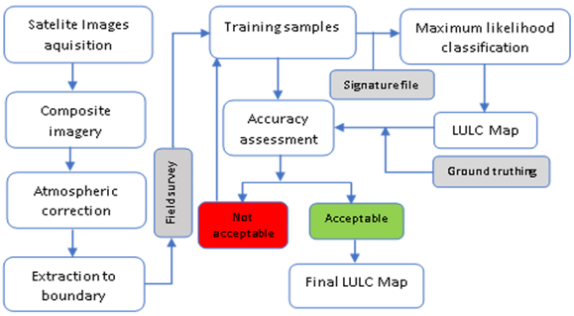

Fig. 2. Summary of the methods applied.

Accuracy assessment was based on the collected 100-150 points for each land cover class resulted from the fieldwork. The difference in points was based on the accessibility and ambiguity in identifying the ground features from the satellite images. The overall classification accuracy of each image was calculated from the total number of correctly classified pixels divided by the total number of sample points used in accuracy assessment (Foody, 2008). Thereafter, the Kappa statistics (Kappa coefficient) was calculated from the classified map and reference data. The procedure for image classification and accuracy assessment is summarized in Fig. 2.

Results

Demographic characteristics

Findings on demographic characteristics such as gender, education level and age groups were assessed. On gender, the average of males was generally higher than that of females, 54% and 46%, respectively (Table 3). However, at the village level, the proportions varied. For example, In Losinyai, the proportion of males and females were equal. However, Orjoro no.5 females were more than males, and in Shambarai Sokoni, males were more than females.

The high proportions of males overall could have happened by chance. Age on average, most respondents (64%) were aged between 20 and 49 years, thus implying the majority were youths thus capable of undertaking various economic activities. Shambarai Sokoni and Orjoro no.5, villages with a high proportion of youths, had 78% and 64% proportions, respectively.

Table 3. Respondents demographic information.

Respondent's age		Time spent in the village (Years)		Education level		Economic activities	
Age Group	Percentage (%)	Time (Years)	Percentage (%)	Education Level	Percentage (%)	Economic activity	Percentage (%)
20-29	11	**<1**	6	Informal Education	39	**Farming**	**32**
30-39	37	**1 – 5**	38	Primary education	35	Livestock keeping	35
40-49	20	>5	56	Secondary education	24	Business	2
≥50	32			College/University	2	Mining	2
						Farming and livestock keeping	29

On education level, a large proportion (77%) of the respondents in all villages had either informal or primary education; this indicates that most of the community members have a low level of education, Losinyai being the most hit had with a population of 91%. The high level of illiteracy can be attributed to an inadequate number of schools with no secondary school. The Ward secondary school is located very far from the village, about 10km. Concerning the duration of stay in the villages, most respondents interviewed (56%) had spent more than five years in their village, which implies that most respondents have experienced different land uses and climate changes in their areas.

Land use changes

Accuracy assessment

The overall accuracy assessment of the supervised images for the years 1987, 2014 were 90.11%, 92.17%, respectively (Table 4). The minimum accuracy is 85%;

thus, these results are sufficient for land use/cover change analysis (Ahmed *et al.*, 2013; Araya and Cabral, 2010). Therefore, the results of this study are in agreement with the requirements of more than 80% (Jensen, 2007).

Table 4. Accuracy assessment results of the classified images.

Area	Year	Overall Accuracy	Kappa Coefficient
Losinyai	1987	88.77	0.906
	2014	90.11	0.912
Oljoro No. 5	1987	87.23	0.903
	2014	91.32	0.931
Shambarai	1987	86.43	0.899
	2014	90.22	0.921

Extent of land use/cover changes

The land cover for each village, i.e., Losinyai, Oljoro no. 5, and Shambarai Sokoni, were assessed separately. Generally, the results show changes in land use/cover at different dimensions.

Land cover changes in the Shambarai Sokoni grazing area

The land cover of the Shambarai Sokoni grazing area is depicted in Fig. 3a and 3b. The results show that in 1987 a large area was occupied by shrubs and grassland (50%) followed by bare soil (39%), woodland (8%) and farmland (3%).

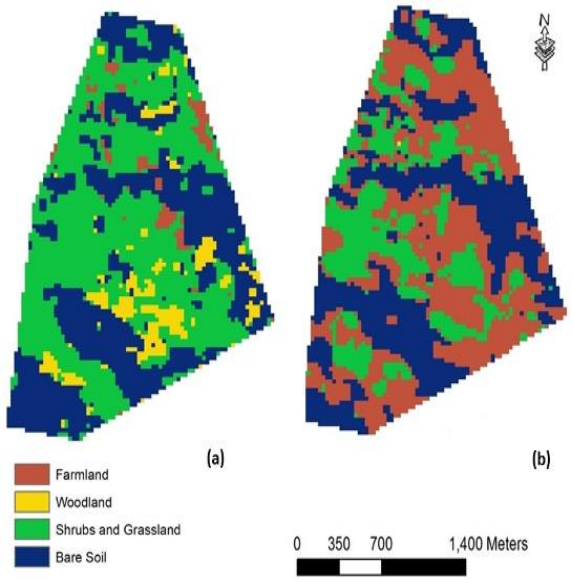

Fig. 3. Land cover/use maps in Shambarai Sokoni grazing area for 1987 (a) and 2014 (b).

This result implies that in 1987 the level of encroachment was low in the grazing area. The possible reason is that in 1987 the population in the village was low and hence low pressure in the grazing area. In 2014, land cover in the Shambarai Sokoni grazing area changed in contrast to 1987, whereby farmland increased by 39% (1.64km^2) while shrubs and grassland decreased by 27% (1.12km^2), woodland decreased by 8% (0.33km^2), and bare soil decreased by 4% (0.19km^2). This result implies that from 1987 to 2014, human encroachment such as agricultural expansion and settlement increased into grazing land. The changes are summarized in Fig. 4.

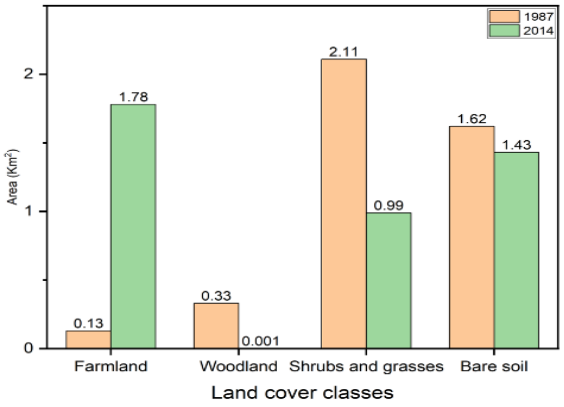

Fig. 4. Land use changes for Shambarai Village for 1987 (a) and 2014 (b).

Land cover changes in the Losinyai grazing area

In the Losinyai grazing area, results of land cover analysis of 1987 (Fig. 5a and 5b) show that the large area was occupied by bare soil (45%) followed by shrubs and grassland (33%), woodland (12%), and farmland (10%).

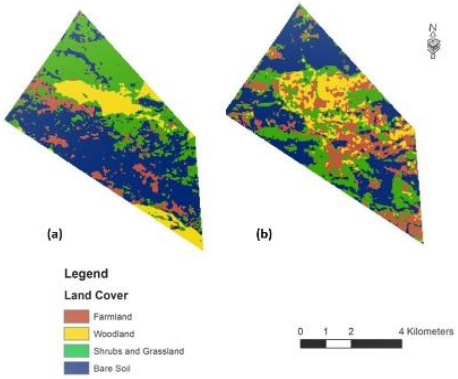

Fig. 5. Land cover images for Losinyai Village for 1987 (a) and 2014 (b).

This result implies that in 1987 the level of encroachment was low in the grazing area. The possible reason is that in 1987 the population in the village was low and hence low pressure in the grazing area. However, in 2014, land cover in the Losinyai grazing area changed contrast to 1987, whereby farmland increased by 13% (4.57km²) and woodland increased by 1% (0.36km²) while Bare soil decreased by 9% (3.08km²) and shrubs and grassland also decreased by 5% (1.85km²) as depicted in Fig. 6. This result implies that from 1987 to 2014, human encroachment such as agricultural expansion and settlement increased into grazing land.

Land cover changes in the Orjoro no.5 grazing area

In Oljoro no.5 grazing area, results of land cover/use analysis of 1987 (Fig. 7a and &b) show that the large area was occupied by shrubs and grassland (85.4%) followed by bare soil (9.9%), woodland (3.2%) and farmland (1.5%).

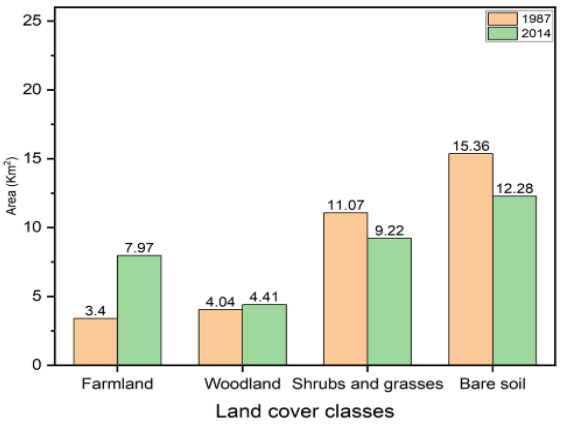

Fig. 6. Land use changes for Losinyai Village for 1987 and 2014.

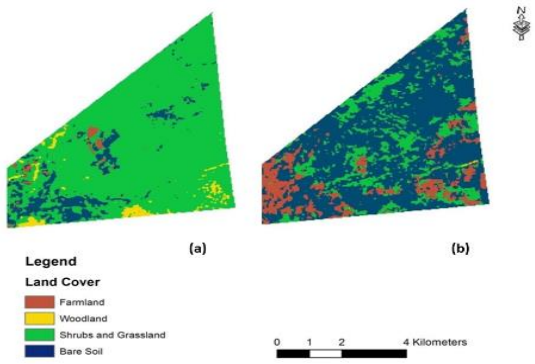

Fig. 7. Land cover images for Oljoro No. 5 Village for 1987 (a) and 2014 (b).

This result implies that in 1987 the level of encroachment was low in the grazing area. The possible reason is that in 1987 the population in the village was low and hence low pressure in the grazing area. In 2014, land cover in Oljoro no.5 grazing area changed in contrast to 1987, whereby farmland increased by 11% (3.82km²) and also bare soil increased by 56.9% (18.74km²) while shrubs and grassland decreased by 65.4% (21.54km²) and woodland decreased by 3.1% (1.03km²). This result implies that from 1987 to 2014, human encroachment such as agricultural expansion and settlement increased into grazing land. These results are summarized in Fig. 8.

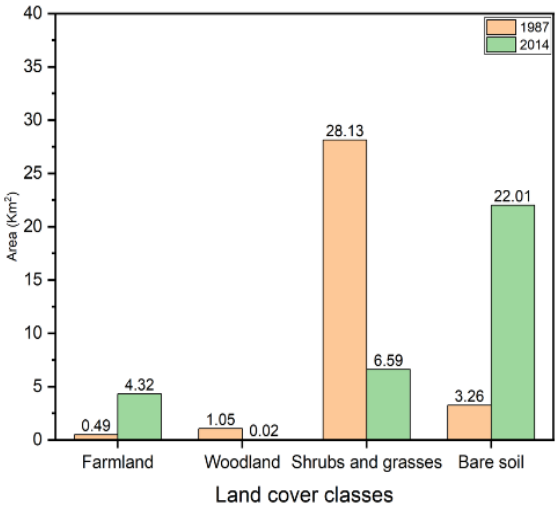

Fig. 8. Land use changes for Oljoro No. 5 Village for 1987 and 2014.

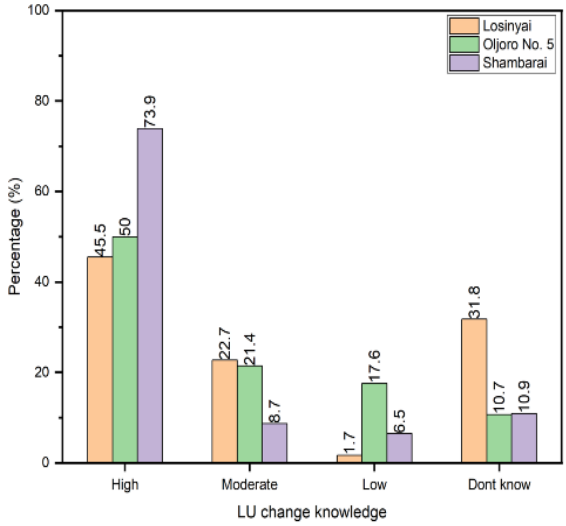

Fig. 9. Knowledge on land use changes.

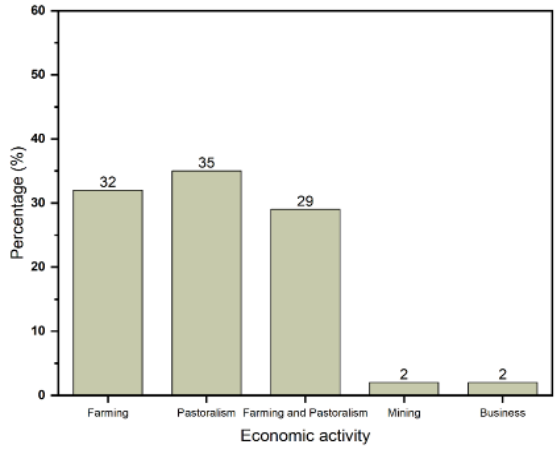

Fig. 10. Reasons for the increased land use changes.

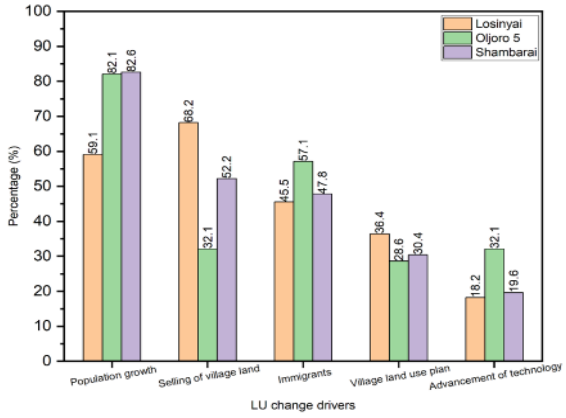

Fig. 11. Drivers of land use changes.

Awareness of Land use changes

Using binary logistics, various variables were tested to know their significance in understanding land-use changes (Table 5). The variables selected for binary logistic regression were: sex, age, education level, marital status, number of years spent by the respondent in a particular area, and the main activities done by respondents. Only three variables were significant at a 95% level of significance, that is, education level ($p<0.016$), number of years spent by the respondent in a particular area ($p<0.04$), and main economic activities ($p<0.007$). The remaining variables such as sex, age and marital status were not significant. As for education level, households with secondary education and/or college level were more likely to understand land-use changes than those with informal education. Regarding the duration of stay, households with more than five years are more likely to be aware of land use changes than those who lived below one year in a particular area. It was also observed that households whose main activities were livestock keeping were more aware of land use changes than farmers or miners.

Effects of land use changes

The common effects of Land use changes mentioned by villagers are loss of grazing land, a decrease of livestock production, land use conflicts, a decrease of household income, family separation and loss of water sources (Table 6). In all villages, loss of grazing land was mentioned as the main effect of land use changes where over 80% of responses mentioned it, followed by land use conflicts. However, the situation is critical in Losinyai village, where 100% of the respondents stated the loss of grazing land as the main effect of land use changes.

Table 5. Binary logistic results.

						95% C.I for Exp (B)	
Variables	B	S.E	Wald	p	EXP(B)	Lower	Upper
Sex	-0.874	0.870	1.010	0.315	0.417	0.076	2.294
Age	-0.501	1.120	0.200	0.655	0.606	0.067	5.440
Education	1.06	0.2	20.266	0.016	2	0.5	6
Marital status	0.00	7.691	0.00	0.999	0.000	0.000	4
Years stayed	1.807	1.377	13.723	0.40	6.092	0.410	13.472
Activity	-0.063	1.309	7.002	0.007	1.000	0.072	12.210

Table 6. Effect of land use changes.

Effect of land use change	Name of villages		
	Losinyai	Orjoro no. 5	Shambarai Sokoni
Loss of grazing land	100%	89.3%	97.8%
Decrease of livestock production	18.2%	32.1%	28.3%
Land use conflicts	50.0%	64.3%	65.2%
Decrease of house hold income	22.7%	0.00%	6.6%
Family separation	22.7%	21.4%	19.6%
Loss of water sources	22.7%	21.4%	23.9%

Discussions

Pattern of land use changes

Farmland

The increase in farmland may be attributed to the population increase and change in lifestyle of pastoral community (Maasai) as they are now involved in crop production too. According to the national bureau of statistics, the population of Oljoro No. 5 ward was 9636 people, whereas the population increased to 15375 people in 2012; this translates to a 59.5% increase in 20 years. Other possible reasons for expansion in farmland could be climate change and livestock reduction due to pasture and water stresses experienced in these villages. The loss of livestock resulted in pastoralists moving into agriculture as means of livelihood and income generation. Decrease in Loisinyai woodland area may be attributed to the establishment of grazing areas protected by community by-laws. On the other hand, the reasons for the total conversion of the woodland areas in Orjoro and Shambarai could be the expansion of farms and settlement caused by Maasai livelihood changes. Other possible reason could be the increase in population, which goes together with an increase in anthropogenic activities. Also, the possible reasons could be high population because the village is very close to Mirerani mine and Arusha city, which influence human activities like an expansion of settlement and farms and charcoal making activities. The possible reasons for the changes in Orjoro village could be an increase in population, which motivated the conversion of bare soil into agricultural farms. These changes in Loisinyai and Shambarai could expand agricultural activities where some bare soil was converted into farmland. Other possible reasons could be that the village is very close to Mirerani town and Arusha city, so it is possibly affected by urbanization impact. Finally, the possible reason for these increases in barren land in Orjoro village could be settlement expansion, which involved clearing forests and shrubs.

Shrubs and grassland

Overall, shrubs and grassland continued to decrease over the years in all villages. For example, between 1987 and 2014, in Losinyai, shrubs and grassland decreased by 16.7%, in Orjoro no.5, the decrease was by 76.6%, and in Shambarai Sokoni, the decrease was by 11.72% (Fig. 4, 6, and 8). The decrease could be attributed to the increase of population, expansion of agricultural farms, and change of Maasai livelihood from pure pastoralism to agropastoralism. Basing on these changes, the data showing the situation was critical in Orjoro no.5, where the shrubs and grassland decreased from 28.1km^2 in 1987 to 6.6km^2 in 2014. These changes, as explained previously, could be attributed to population increase and immigrants who opened big farms in the village. Apart from that, selling land to investors and advancing technology also motivated the conversion of shrubs and grassland to farms and settlements. Households were also interviewed on land use/cover changes in the area. The responses were categorized into high, moderate, low, and do not know.

Overall land use changes were perceived to be high; for example, In Shambarai Sokoni, about 73.9% perceived the changes as “high”. In Orjoro no.5, about 50% perceived the changes as high, and also in Losinyai village, the proportion was 45.5%. Regarding the high rate of land use changes in all villages, the possible reasons could be the population growth, immigrants, and land sell. For example, in Losinyai village, a new settlement established along Simanjiro-Arusha road reduced the grazing area. It blocked the migratory livestock route from Losinyai to Orjoro no. 5 villages and Komoro ward, which formally were used to move cattle during drought condition. In the southern part of the village, there is a sprawl of new farms introduced by immigrants cultivating mainly legumes varieties: Lablab, Green gum, and common peas; these varieties have high drought resistance capability. Farmers' expansion started to encroach on the grazing area and pose many challenges to the pastoralists, including blockage of cattle grids and loss of grazing land.

Apart from that, the possible reasons for land use/cover change comply with the household questionnaire findings on the causes of land

use/cover change. Most of the respondents in all village respondents that the major cause of land use/cover changes is population increase. For example, in Losinyai village, the proportion of responses was 59.1%; in Orjoro no.5, the proportion was 82.1% and 82.6% in Sokoni. These findings comply with the Msoffe (2010) study in Maasai land, where the human population was seen as the major driver of environmental changes. Fig. 9 summarizes the knowledge and perception of land use changes by community members.

Perception of community on the causes and effect of land use changes

Village leaders level perception

The common effects of land use changes mentioned by village leaders were loss of grazing land, decreased livestock production, land use conflicts, decreased household income, family separation, and loss of water sources. In all villages, loss of grazing land was mentioned as the main effect of land use changes where over 80% of responses mentioned it, followed by land-use conflicts. Moreover, 100% of all the respondents in the Losinyai village pointed out the loss of grazing land as the main effect of landuse changes in their village. Also, land cover change analysis shows that there was highly land conversion in Losinyai village from grazing land to cultivation land and settlement compared to other villages. These findings imply a significant loss of grazing land in all villages, which directly affects the livelihood of the pastoral community. Furthermore, physical observation shows total blockage of the traditional grazing routes between Losinyai and Orjoro no. 5 villages. The blockage of the important route limits livestock to access water and pasture during dry season hence the death of many livestock.

As for key informants, which involved village leaders, CEOs, and livestock field officers agree that land use/cover changes in their areas have different reasons. Some of the reasons mentioned were population increase and immigrants, change of Maasai lifestyle and climate change. For example, the village chairman in Losinyai village stated that most of the grazing land was taken by immigrants from the Arusha region who came to establish big farms to cultivate lablab, green gum, and common peas. This conversion left village dwellers with a small portion of land that is not enough to graze large livestock herds.

Also, the livestock officer in Orjoro no.5 ward stated that many farms and settlements were established by both indigenous and immigrants in the southern part of Losinyai village, where formally the area was covered by woodland and was used as the grazing area. These explanations revealed that there is a high level of land use changes caused by indigenous population increase, immigrants, and land sales.

Further, the village chairman in Shambarai Sokoni village chairman uncovered that the high rates in land-use changes in the village are caused by the increase of the population as the effect of the tanzanite mine. Most of the small scale miners and local villagers are the owner of many farms in the village. He added that “Currently even Maasai sell their cattle to get money for buying cultivation land because they realized the benefits of cultivating maize rather than the previous time where only immigrants were practising maize cultivation”. This translates into the unsustainable shifting of the communities from total pastoralism to agropastoralism, resulting in the high conversion of pastureland to agriculture.

Household-level perception

The possible explanation could be their broader understanding of issues such as land use change and farming systems. This could be explained by their vast experience with different changes happening in the area. It was also observed that households whose main activities were livestock keeping were more aware of land use changes than farmers or miners (Fig. 10). This can be explained by the fact that communities in the area are mostly pastoralists who depend on water and pasture for their livelihood.

The findings of this study comply with the study done by Campbell *et al.* (2003) in the Kajiado district in Kenya.

The study revealed that most of the Maasai pastoralists grazing land were converted to conservation area during the establishment of Tsavo and later Amboseli National Park.

Effects of land cover changes on grazing land
Blockage of livestock migratory routes
Movement allows livestock to shift from low productivity parts of the rangeland with low fertility, sparsely distributed vegetation, and low availability of permanent water to high-productivity areas which may have a permanent water source and more fertile grazing areas (Ykhanbai *et al.*, 2014). By careful and planned use of both areas, pastoralists can optimize outputs from the rangeland system as a whole (Ykhanbai *et al.*, 2014). However, if moving from one area to another is restricted or blocked, overuse of resources will likely result, leading to rangeland degradation and ultimately increased vulnerability to drought (Ykhanbai *et al.*, 2014).

The results of this study are in agreement with other studies in different parts of the world. The traditional movement of traditionally mobile communities in increasingly being restricted are blocking due to land use changes, including expansion of agricultural farms, allocation of the conservation area, and settlement development was reported in parts of Southern Kenya and northern Tanzania (Butt *et al.*, 2009). In parts of Uganda specifically, the decrease of rangelands in Buliisa and Nakasongola was reported to affect livestock basic grazing resources (Byenkya *et al.*, 2014). This decrease is attributed to increasing cultivation, bush and woody encroachment.

In Nakasongola, the increase in bare lands contributed to declining grasslands. Increased conversion of rangelands into cultivation land was caused by population growth which influenced the high demand for food, especially by immigrants from different areas who carried with them their former land-use practices (Byenkya *et al.*, 2014). Expansion of agricultural activities put stress on native grassland species, pushing grazing pressure upon grasslands (Priess *et al.*, 2011).

Also, in east African countries, most highlight areas of high biodiversity are lost to mineral extraction (William and Mungo, 2003). The conversion to mining and power projects accounted for minimizing the rangelands, hence affecting pastoralism and pastoral livelihood in general. For example, In Tanzania, 200km^2 of Selous Game Reserve was excised or downsized to make room for a uranium mining site (Olson, 2006). In the United States of America, the conversion of native grassland for crop production has become an important issue in policy debates (Claassen *et al.*, 2010). Environmental practitioners, wildlife groups, and livestock experts have become particularly concerned about losing native grasslands in the Northern Plains region (GAO). Between 1982 and 1997, 34.3 million acres of cultivated cropland were converted to hay or pasture, and 3.0 million acres transitioned to range (Claassen *et al.*, 2010). On the other hand, 22.7 million acres of hay and pasture and 5.5 million acres of rangeland were converted to cultivated crop production (Claassen *et al.*, 2010).

Change of grazing resources distribution (water and pastures)
The changes in pastures and water distribution impact pastoralism in many dimensions; studies show that the changes are occurring in land use and climate limit water and pasture distribution in a given area (William and Mungo, 2003). The location and number of pasture and watering points are the main factors in determining the movement of the grazing animals, distribution, and concentration(Roever *et al.*, 2015). For example, agricultural land preparation involves clearing vegetation, which may reduce vegetation cover and either change or lead to a complete loss of primary vegetation (Tilman *et al.*, 2011). Also, temporal and spatial changes in land use/ cover, including expansion of cultivated lands into natural vegetation types (grasslands, bushland, wetland, and forests), increased bare ground (Byenkya *et al.*, 2014). Temporal changes included the regeneration of woodlands after clearance for wood and charcoal production and land cultivation (Byenkya *et al.*, 2014).

Drivers of land use changes

The causes of land use changes are analyzed through multiple responses (Fig. 11). In Losinyai village, 68.2% mentioned selling village land as the leading cause of land use changes where village leaders sell the village land (public land) to investors who are mainly crop cultivators.

The selling of village land is viewed as the illegal source of income of the few village leaders who are not putting forward public interests. The buyers (who are not mostly indigenous) convert the land into farms for agricultural production. Accordingly, this is a serious problem that might finish all public land in the near future and leave the locals without public grazing areas.

In the rest two villages (Orjoro no.5 and Shambarai Sokoni), most of the responses show that population growth is the main cause of land use changes over the area (Fig. 10). This finding reveals that the population increase over the area acted as the main driver of the conversion of grazing land to settlement and agricultural farms. Both villagers and immigrants opened new farms to cultivate enough food for feeding their families and for exportation. Discussion with the few leaders of Shambarai Sokoni village showed that the growth of population per household influenced the expansion of farms in the village, hence converting many grazing areas into farms and settlement. Based on this situation, if population growth is not controlled in the long run, all open land, particularly public grazing land, will be invaded, causing great land use conflicts over the area. Other factors contributing to land use changes are immigrants, Village land Use plans, and technology advancement**.** However, in all villages, leaders mention population growth as the primary cause of land use changes in their administrative areas (Fig. 11).

Conclusion

This study revealed the rapid and unsustainable transformation from transhumance with large livestock herds to agropastoralism with small livestock herds. This transformation was triggered by the loss of grazing land and livestock loss due to a shortage of pastures and water resulting from climate changes. As a result, this phenomenon triggers more land use/cover changes in the study area.

The closure of this important route limits livestock access to water and pasture during the dry season, hence the death of many livestock, which in most cases will not be readily acceptable to livestock keepers. This situation threatens the peace and stability of the area because the shortage of grazing land will likely cause land use conflicts over the area. The results show that the local populace is informed of the current land use/cover changes and the associated impacts.

The results of this study suggest measures to create a balance between utilization and conservation. This study show the resource need to train livestock keepers on the modern techniques that utilize a small area with more productive breeds. Advancement of the current policies and practices by considering the needs and requirements of the pastoral communities during environmental planning is envisaged to create a balance between resources utilization and conservation for all land use groups.

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